SECTION 7: ENERGY AND WATER CONSCIOUS DESIGN

7.1 General. This section provides instructions for the incorporation of energy and water conservation into medical facility designs. Subject to medical functional requirements and project funding limitations, conservation features shall be incorporated when demonstrably cost effective in accordance with this section. This section is applicable to new facilities, and to those portions of existing buildings undergoing upgrade or alteration. This criteria is in accordance with the following directives: Title 10 CFR, Subpart A, Part 435, "Energy Conservation Voluntary Performance Standards for New Commercial and Multi-Family High Rise Residential Buildings, Mandatory for Federal Buildings (reference 7a), the Federal Energy Management Improvement Act of 1988 (reference 7b), The Energy Policy Act of 1992 (reference 7c), and Executive Order 12902 (reference 7d).

7.1.1 Alteration/Addition Projects. For alteration or addition projects, these criteria shall not be applied to portions of the building or systems not affected by the work. It would not be expected, for example, that in an addition project, wherein the existing facility's chilled water network is extended to provide cooling for the addition, the project need consider energy upgrade to the overall chilled water system.

7.2 Policy.

7.2.1 Medical Function. Energy and water conservation features shall not restrict or interfere with medical functional requirements, cause a reduction in or dependability of required services, or result in inability to achieve environmental conditions required by this manual.

7.2.2 Proven Technologies. The technologies utilized in the design shall be proven in similar applications in the industry, and must be readily available and competitively procurable.

7.2.3 Utility Incentive Programs. Military Departments are authorized to participate in utility incentive programs (references 7c, 7d, and 7e). These programs are typically associated with load management, involving efficiency maximization and demand control. Medical facility designers shall investigate the availability and applicability of any such programs offered by the serving utilities, for consideration of their incorporation into the design.

7.2.4 Energy and Water Conservation Program. The Office of the Deputy Under Secretary of Defense for Environmental Security (DUSD-ES) is responsible for administering the Federal Energy Management Program (FEMP) and the Energy Conservation Investment Program (ECIP). These programs are designed to improve the energy efficiency of new or existing DOD facilities within MILCON project guidelines. The DUSD-ES will give the highest funding priority to projects and programs that provide the greatest cost-effective energy or water use reduction and savings-to-investment ratios. Military Departments should develop valid ECIP or FEMP projects in accordance with reference 7f with an accompanying DD Form 1391 justifying the proposed project and submit to OASD-HA DMFO for inclusion into their submission to DUSD-ES.

7.2.5 Economic Study. Designs shall consider all potential energy conserving features, equipment, systems or strategies as may be applicable to

the particular project. Those which are considered to have the greatest potential for cost effective application, based upon the experience and professional judgement of the designer and Design Agent, shall be the subject of more detailed economic analysis. These analyses shall be utilized in the selection of project systems and equipment. More detailed discussion of system economic analysis requirements is contained elsewhere in this section.

7.2.6 Metering. Utility services, including electricity, gas, steam, heating water, and chilled water, shall be metered. The meter shall have the capability of digital communications with a central post-wide (or hospital campus) Monitoring and Control System.

7.3 Design Considerations.

7.3.1 Passive Solar Energy. The use of passive solar energy conservation techniques shall be considered. Earth sheltering and berming shall be used if cost effective and if in keeping with overall site and architectural considerations. Building orientation and shading shall be arranged, when practicable, to minimize solar cooling load and maximize winter daylighting.

7.3.2 Interior Design Conditions. The required interior design conditions are listed in Appendix A of this manual. For those applications or requirements not specifically addressed in Appendix A, consult ASHRAE publications or equivalent sources.

7.3.3 Equipment Operating Efficiencies. The minimum operating efficiencies for energy consuming equipment shall be in accordance with the 10 CFR 435 (reference 7a) and the applicable military departmental guide specifications. Incorporate the highest equipment efficiencies determined to be competitively available and life-cycle cost effective for the individual project.

7.3.4 Thermal Transmission Values. The maximum thermal transmission values utilized in the design shall be in accordance with Table 7-1. The insulation values may be altered when determined to be cost effective, utilizing life-cycle cost analysis, for the given climatic conditions and building operational characteristics.

7.3.5 Energy Source Selection. The energy source for the heating and cooling systems, service water heating, and process loads shall be selected in accordance with the requirements set forth in the Defense Energy Program Policy Memorandum titled "Defense Facilities Energy Selection" (DEPPM 88-1) (reference 7g). In essence, this criteria requires that the energy source shall be the most life-cycle cost effective, determined by analysis of the available and reliable alternatives. The use of nonconventional or alternative energy sources is encouraged if proven reliable and demonstrably cost effective. Energy or fuel supply contracts with third party financing are also encouraged and shall be considered prior to authorizing a new heating or power plant. Refer to DEPPM 88-2 (reference 7h) titled "Private-Sector Financed Defense Energy Contracts" for privately financed Defense energy contract guidelines.

7.3.5.1 Total Energy System. Total energy systems shall be considered for major facilities as directed by the Design Agent.

7.3.5.2 Renewable Energy Systems. Designers shall consider the economic practicability of renewable energy systems, such as solar, wind, and geothermal energy, for each project. When recent economic studies for similar facilities in the project's climatic region demonstrate that such systems are not life-cycle cost effective, those studies may be cited in lieu of conducting new analyses.

7.3.6 Utility Costs. The utility cost data shall be ascertained from the Installation's contracting office, or other approved source as directed by the Design Agent. Utility cost escalation rates utilized in economic studies shall be in accordance with Energy Price Indices and Discount Rates for Life-Cycle Cost Analysis (reference 7i).

7.3.7 Equipment and Utility Monitoring and Control System. In hospitals, and other MTF's as required by the Using Service and coordinated with the Design Agent, a central monitoring and control system located within the facility shall be incorporated into the design to provide central monitoring, reporting, and control parameter adjustment capability. Connection to an existing Utility Monitoring and Control System (UMCS) or Energy Monitoring and Control System (EMCS) shall be as required by the Using Service and coordinated with the Design Agent.

7.4 Facility Energy Performance. Each facility shall be designed so that its Design Energy Usage (DEU) does not exceed the Design Energy Target (DET) established in accordance with this section. The DET is an energy-use performance target for the facility, which excludes energy required to provide for medical functions, i.e. process loads, as defined further below. It is not the intent to prioritize compliance with the DET over considerations of life-cycle cost in the design and selection of building elements, equipment and features. The DET compliance is a tool to help assure that designs incorporate all practicable and cost-effective energy saving opportunities.

7.4.1 Design Energy Target (DET). The DET's are established at Table 7-2 on the basis of facility type and climactic region. As indicated in the notes to Table 7-2, the DET's are based on defined operating schedules. For the purpose of comparing project DEU, facility energy consumption must be modeled on the same operating schedule. Further guidance for computer modeling is provided below.

7.4.2.1 Design Energy Usage (DEU). The DEU is a calculation of the estimated energy consumption of a project facility, and is not to exceed the DET. The DEU shall be calculated by the designer during the concept design, and shall be updated as necessary thereafter based upon Design Agent requirements. The DEU shall include all the energy required for conditioning and ventilation systems (heating, cooling, and humidification) energy, lighting, and domestic hot water generation required to provide for occupant comfort and amenities. The DEU shall not include process loads, such as energy used in laboratories, central material, food service, or ancillary support operations. Similarly, energy required to compensate for the cooling or heating loads associated with those operations shall not be included. Service distribution system losses are included in the DEU if supplied from a plant dedicated to the project facility. The area used to determine the DEU shall be the gross area measured from the outside of the exterior walls.

7.4.2.2 Total Design Energy Usage (TDEU). The TDEU is an estimate of the future energy consumption required to condition and operate the facility,

serving to enable Users to predict the future energy demands and costs for a particular facility. When required by the individual military department, TDEU shall be calculated during concept design. The calculation shall include all facility energy demands, including process loads, and shall be modeled on the actual schedule of operation intended for the facility.

7.5 Design Analysis. Medical facility design projects require analysis of building heating and cooling loads, annual energy consumption, and life-cycle cost economics, to serve as the basis of equipment and systems selections. Subject to compliance with medical functional requirements and project funding limitations, selection of energy consuming systems and design features shall be based on Life-Cycle Cost Analysis (LCCA) of the relative energy, maintenance, and initial costs.

7.5.1 Energy/Load Analysis. Energy and load analyses for all new facilities, additions, and major alterations larger than 280 gross square meters (3000 gross square feet) shall be conducted with the use of a computer program utilizing a calculation method recognized in the ASHRAE Fundamentals Handbook. The computer program is to be acceptable to the Design Agent, and utilize an hour-by-hour calculation procedure. For projects less than 280 gross square meters (3000 gross square feet) analysis may be by an accepted computer program or by manual calculations in accordance with the Fundamentals Handbook.

7.5.2 Life-Cycle Cost Analysis (LCCA). LCCA shall be executed in accordance with the procedures specified in the National Institute of Standards and Testing (NIST) Life-Cycle Cost Handbook (reference 7j), and supplemental military departmental criteria as appropriate. The present worth discount rate, and future fuel escalation rates, used in the LCCA shall be those published in reference 7i. Unlike the energy analysis, LCCA's shall be based on actual operating hours, and shall realistically reflect first purchase, installation, operations, maintenance, and replacement costs that occur within the study period. Designers are cautioned that although most energy/load programs are available with life-cycle cost programs, many of these are not in accordance with the NIST Handbook, or may not utilize the correct discount factor. Consult with the Design Agent to identify acceptable programs.

TABLE 7-1

MAXIMUM THERMAL TRANSMISSION VALUES FOR
DoD MEDICAL AND DENTAL TREATMENT FACILITIES

WATT/m^2-^oC (BTU/hr-ft^2-^oF)

HEATING (1) DEGREE DAYS °C (°F)	GROSS WALL(2) U_O	OPAQUE WALLS(3) U_W	CEILING/ ROOF(4) U_R	FLOOR SPACE(5) U_{F5}	FLOOR GRADE(6) U_{FG}
Less than 560 (Less than 1000)	2.15 (0.38)	0.853 (0.15)	0.284 (0.05)	0.568 (0.10)	1.647 (0.29)
561-1110 (1000-2000)	2.15 (0.38)	0.853 (0.15)	0.284 (0.05)	0.454 (0.08)	1.363 (0.24)
1111-1670 (2001-3000)	2.048 (0.36)	0.568 (0.10)	0.227 (0.04)	0.397 (0.07)	1.192 (0.21)
1671-2220 (3001-4000)	2.048 (0.36)	0.568 (0.10)	0.170 (0.03)	0.397 (0.07)	1.022 (0.18)
2221-3330 (4001-6000)	1.760 (0.31)	0.454 (0.08)	0.170 (0.03)	0.284 (0.05)	0.794 (0.14)
3331-4440 (6001-8000)	1.590 (0.28)	0.397 (0.07)	0.170 (0.03)	0.284 (0.05)	0.683 (0.12)
Over 4441 (Over 8000)	1.590 (0.28)	0.397 (0.07)	0.170 (0.03)	0.284 (0.05)	0.568 (0.10)

TABLE 7-1 NOTES

(1) Degree-Day value from the joint service Manual TM 5-785, NAVFAC P-89 and AFM 88-29 Engineering Weather Data shall be used.

(2) Gross wall (U_O) values include all doors and windows, window frames, metal ties through walls, structural steel members that protrude through all insulation to the exterior, or adjacent to the exterior, and continuous concrete or masonry walls or floors that extend from inside heated spaces through the building envelope to the exterior, e.g., fire walls that extend above the roof and concrete floor slabs that extend beyond the exterior walls to form a balcony or terrace. Maximum U_O value will put a limitation on the allowable percentage of glass to gross wall area in a building. It should be noted that in hospital, medical, and dental facilities, which are positively pressurized, the 10 percent limitation on glass to gross wall area for walls facing a prevailing winter wind might not be appropriate. Insulating glass on the building will allow a higher percentage of glass in comparison to single pane glass. The U-value of each wall component shall be factored by the percent of the total area it covers.

TABLE 7-1 NOTES CONTINUED:

(3) Wall (U_W) value is the thermal transmittance of all elements of the opaque wall area. U_W values shall be used for upgrade of existing facilities where the alteration of the wall cavity and resizing of window glazing to meet gross wall values (U_O) are not cost effective. There may be situations where upgrading all the perimeter walls in low, medium, and high internal loaded spaces to the specified transmission value may not be life-cycle cost effective. The designer will recommend appropriate alternatives when such situations occur, providing supporting life-cycle cost data based on appropriate hour-by-hour computer simulations. This requirement to assess the above-mentioned situation may necessitate a variation from the values set forth in this table.

(4) Ceiling/roof (U_R) values are for ceiling/roof areas where adequate space exists for insulation to be applied above ceiling and/or below roof structure. Built-up roof assemblies and ceiling assemblies in which the finish interior surface is essentially the underside of the roof deck will have a maximum U_r value of 0.284 (0.05) for any Heating Degree-Day area.

(5) Floor, space (U_{FS}) values are for floors of heated space over unheated areas such as garages, crawl space, and basements without a positive heat supply to maintain a minimum of 10 °C (50 °F).

(6) Floor, grade (U_{FG}) values are for slab-on-grade insulation around the perimeter of the foundation.

TABLE 7-2

DESIGN ENERGY TARGETS (DET) FOR DoD MEDICAL AND DENTAL (1) TREATMENT FACILITIES - MJ/m^2/yr (1000 BTU/ft^2/yr))

BUILDING CATEGORY CODE		REGION 1	REGION 2	REGION 3	REGION 4	REGION 5	REGION 6	REGION 7
(2) CDD (3):		< 1110 <(2000)	< 1110 <(2000)	< 1110 <(2000)	< 1110 <(2000)	< 1110 <(2000)	> 1110 >(2000)	> 1110 >(2000)
HDD (3):		> 3885 >(7000)	3055-3885 (5500-7000)	2220-3055 (4000-5500)	1110-2220 (2000-4000)	0-1110 (0-2000)	0-1110 (0-2000)	2000-1110 (2000-4000)
510 Hospital Buildings	(4)	1530 (135)	1530 (135)	1190 (105)	1140 (100)	1140 (100)	11909 (105)	1250 (110)
530 Laboratories	(5)	510 (45)	510 (45)	400 (35)	400 (35)	400 (35)	400 (35)	400 (35)
540 Dental Clinics	(5)	740 (65)	740 (65)	620 (55)	570 (50)	450 (40)	510 (45)	680 (60)
550 Dispensaries	(5)	740 (65)	740 (65)	570 (50)	510 (45)	400 (35)	450 (40)	620 (55)

TABLE 7-2 NOTES:

(1) Energy consumed within 1.5 m (5 ft) line, based on Dept. of Energy building categories and weather zones. The DET for a building within which more than one category is found shall be the sum of the area-factored DET's for the given categories. A minimum 10% of the total area shall be dedicated to the given category to be factored into the DET.

(2) Degree-Day value from the joint service Manual TM 5-785, NAVFAC P-89 and AFM 88-29 Engineering Weather Data shall be used.

(3) Cooling Degree Days - CDD; Heating Degree Days - HDD

(4) 24 hours/day, 7 days/week.

(5) 10 hours/day, 5 days/week.

TABLE 7-3

ENERGY CONVERSION FACTORS (1)

FUEL TYPE	CONVERSION FACTORS
ANTHRACITE COAL	33 MJ/kg (28.4 MILLION BTU/SHORT TON)
BITUMINOUS COAL	28.6 MJ/kg (24.6 MILLION BTU/SHORT TON)
#2 DISTILLATE FUEL OIL	38.7 MJ/L (138,700 BTU/GALLON)
RESIDUAL FUEL OIL	41.7 MJ/L (149,700 BTU/GALLON)
KEROSENE	37.6 MJ/L (135,000 BTU/GALLON)
LP GAS	26.6 MJ/L (95,500 BTU/GALLLON)
NATURAL GAS	38.4 kJ/L (1,031 BTU/ft^3)
STEAM	2.3 MJ/kg (1000 BTU/LB)
ELECTRICITY (2)	3.6 MJ/kWh (3,413 BTU/kWh)
HEATING HOT WATER, CHILLED WATER	HEAT CONTENT OF FLUID ENTERING THE FACILITY

TABLE 7-3 NOTES:

(1) If a given energy source consistently differs from these conversion factors by greater than 10%, then use the actual unit BTU content value instead of the conversion factor shown.

(2) Electricity is not typically used for space heating. In the exceptional case where it is cost effective and greater than 10% of the annual space heating is derived directly from electric resistive heating, the energy consumed shall be multiplied by 2.2 to account for conversion losses.

REFERENCES

7a. 10 CFR, Part 435, "Energy Conservation Voluntary Performance Standards for New Buildings; Mandatory for Federal Buildings", Subpart A - Voluntary Performance Standards for New Commercial and Multi-Family High Rise Buildings; Mandatory for Federal Buildings", Revised.

7b. Public Law 100-615, "Federal Energy Management Improvement Act", November 5, 1988.

7c. Public Law 102-486, "Energy Policy Act", October 24, 1992.

7d. Executive Order 12902, "Energy Efficiency and Water Conservation at Federal Facilities", March 8, 1994.

7e. Defense Energy Program Policy Memorandum, "Participation in Public Utility Sponsored Energy Conservation and Demand Side Management (EC/DSM) Programs", DEPPM 94-1.

7f. Memorandum OASD(L/MRM), Subject: Energy Conservation Investment Program Guidance, March 17, 1993

7g. Defense Energy Program Policy Memorandum, "Defense Facilities Energy Selection", DEPPM 88-1, October 14, 1988.

7h. Defense Energy Program Policy Memorandum, "Private-Sector Financed Defense Energy Contracts", DEPPM 88-2, September 30, 1988.

7i. National Institute of Standards and Technology (NIST), “Energy Price Indices and Discount Rates for Life-Cycle Cost Analysis”, NISTR 85-3273 (updated every fiscal year).

7j. National Institute of Standards and Technology (NIST) HDBK 135 (Rev), "Life-Cycle Cost Manuals for Federal Energy Management Programs".